91602
new 82-10

COMPLIMENTARY COPY
Please Credit Ontario Hydro Research if
Reproduced in Whole or in Part.

ontario hydro
research division

EXECUTIVE SUMMARY

BOOTH QUARRY GROUND WATER MONITORING SEPTEMBER, 1985

A. Golomb
Environmental & Inorganic Section
Chemical Research Department

Regular monitoring of Booth Quarry fly ash disposal site, Etobicoke, which was initiated in 1976 at the request of the Ontario Ministry of Environment, was continued in 1985. A major decrease (first observed in November, 1982) persists in concentrations of dissolved components of ground water in the central sump, where small shifts in major ion chemistry have been observed; these changes cannot be attributed to simple dilution and remain anomalous for the present. There has been little significant change in water chemistry in the peripheral wells at the site. (Two of these wells are temporarily inaccessible due to local construction.) A piezometric head survey shows that the water table remains fairly steady; the central sump water elevation is slightly lower than those in the other wells. Monitoring continues.

job	file	date	report no.
740631-114-892	837.71	December 18, 1985	85-346-K

91602
new 82-10

ontario hydro
research division

TO: Mr. D. Erwin
Manager, of Procurement -
General Products
Supply Division

Attn: Mr. J.H.P. Buckingham
Senior Supervisor
Ash Management

BOOTH QUARRY GROUND WATER MONITORING SEPTEMBER, 1985

A. Golomb

A major decrease (first observed in November, 1982) persists in concentrations of dissolved components of ground water sampled from the central sump, where slight shifts in major ion chemistry have been observed. Water chemistry in other observation wells sampled at the site has undergone little significant change. (Two peripheral wells are temporarily inaccessible.) Piezometric head measurements show that the water table remains fairly steady. Monitoring continues.

Ground water samples were taken from the central sump and two peripheral monitoring wells (OW-1-82 and OW-6-82) at Booth Quarry ash disposal site, Etobicoke, on September 18, 1985. Sampling locations are shown in Figure 1. Observation wells OW-2-77 and OW-8-77 were temporarily inaccessible due to local construction. Steps have been taken to gain access to these locations during 1986. Analytical results are given in Table I, and major ion balances through 1985 are given in Tables II - VI. A Piper trilinear diagram (Figure 2) for the locations sampled on September 18, 1985 (and, for comparison, those sampled on June 13, 1984/1/) shows that ground waters taken from the central sump, OW-1-82 and OW-6-82 continue to have no dominance of major ions, while ground waters from OW-2-77 and OW-8-77 were, as of June 1984, in the region of dominance of alkaline earths and weak acid anions. Piper diagrams (Figures 3-7) for individual observation wells contain historic data for each location.

Chemical characteristics of central sump water reflect continuation of a major (~20:1) dilution which occurred following the

job	file	date	report no.
740631-114-892	837.71	December 18, 1985	85-346-K

sampling of June, 1982, when concentrations of most components decreased to levels below those reported/2/ for Lake Ontario water. It has been suggested/3/ that the observed dilution might have resulted from infiltration of precipitation and run-off through the still uncovered fly ash fill surrounding the central sump. A temporary shift of central sump major ion water chemistry out of the region of 'no dominance' noted in 1983 was reversed in 1984/1/ and remains in its original condition in 1985. Such changes cannot be accounted for by simple dilution and are, for the present, anomalous.

The concentration of zinc in the central sump notably decreased from 3.9 mg/L, observed in June, 1984/1/, to <0.02 mg/L in September, 1985. This reflects continuing fluctuations of zinc levels above and below the detection limit, observed intermittently throughout the monitoring programme which began in 1976. Such changes are attributable to corrosion of the galvanized well casing. There was also an anomalous rise of cadmium level in the sump (as elsewhere) from below the detection limit of 0.0001 mg/L to 0.0007 mg/L. Similar shifts of cadmium concentration, particularly in the sump, have been previously noted from time to time/4/. It is noteworthy also that the excursions observed are still below maximum acceptable concentrations published in the Ontario Drinking Water Objectives, ie, 0.005 mg/L for cadmium and 5.0 mg/L for zinc/5/.

The 1984-85 piezometric head survey (Table VII) shows little overall change in the water table since the last measurement except that the level in the central sump increased by ~0.5 m above the preceding level. Levels in the other observation wells remain fairly steady, at levels slightly above that in the sump. There is no obvious correlation between the level in the central sump and the major dilution first observed there in November, 1982. Monitoring continues.

Approved by:

O.A. Kupcis
Manager
Chemical Research Department

Prepared by:

A. Golomb
Engineer
Environmental & Inorganic
Research Section

Reviewed by:

D.J. Dodd
Supervising Engineer
Environmental & Inorganic
Research Section

AG:lg

85-346

REFERENCES

1. Research Division Report No 84-389-K.

2. Ontario MOE, 1978. Unpublished data.

3. Research Division Report No 83-15-K.

4. Research Division Report No 80-523-K.

5. "Ontario Drinking Water Objectives." Published by the Ontario Ministry of the Environment, 1983.

TABLE I

CHARACTERISTICS OF GROUNDWATERS AT BOOTH QUARRY ASH DISPOSAL SITE
SEPTEMBER 18, 1985

	Central Sump	OW-1-82	OW-2-77	OW-6-82	OW-8-77
pH	7.0	8.0		7.7	
Sp Conductivity (mS/m)	25.4	109		132	
Alkalinity OH^-	<5	<5		<5	
as $CO_3^=$	<5	<5		<5	
$CaCO_3$ HCO_3^-	47	303		353	
Hardness (as $CaCO_3$)	91	229		428	
Sulphate	57.2	115		292	
Chloride	8.5	98.8		63.1	
Sodium	6.8	134		106	
Potassium	11.0	16.6		25.6	
Calcium	28.3	59.5		108	
Magnesium	5.0	19.6	NA	38.5	NA
Aluminum	<1	<1		<1	
Arsenic	0.001	<0.001		<0.001	
Barium	<0.5	<0.5		<0.5	
Boron	0.46	1.70		2.36	
Cadmium	0.0007	0.0006		0.0006	
Chromium	<0.1	<0.1		<0.1	
Copper	0.003	0.002		0.002	
Iron	<0.05	<0.05		<0.05	
Lead	<0.002	<0.002		<0.002	
Manganese	0.1	0.4		0.2	
Mercury	<0.0002	<0.0002		<0.0002	
Molybdenum	<0.5	<0.5		<0.5	
Nickel	<0.005	<0.005		<0.005	
Selenium	<0.001	<0.001		<0.001	
Strontium	0.19	1.91		4.3	
Titanium	<1	<1		<1	
Vanadium	0.03	<0.02		0.03	
Zinc	<0.02	<0.02		<0.02	
TDS	180	760		920	

Notes: All concentrations given in milligrams per litre.
NA denotes well not accessible due to local construction.

TABLE II

MAJOR ION CHEMISTRY
BOOTH QUARRY - CENTRAL SUMP

CATIONS

	Ca			Mg			Na			K				
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	CATION TOTAL	ANION TOTAL
Sept 18, 1985	28	1.42	59	5.0	0.41	17	6.8	0.30	12	11.0	0.28	12	2.41	2.37
June 13, 1984	35	1.75	74	1.9	0.16	7	9.7	0.42	17	1.6	0.04	2	2.33	2.10
Nov 16, 1983	24	1.20	72	2.6	0.21	13	3.0	0.13	8	4.4	0.11	7	1.66	1.66
June 13, 1983	27	1.35	79	2.4	0.20	12	2.9	0.13	8	0.7	0.02	1	1.70	1.73
Nov 16, 1982	25	1.25	77	2.7	0.22	14	3.2	0.14	8	0.7	0.02	1	1.63	1.55
June 16, 1982	370	18.46	51	114	9.37	26	160	6.96	19	54	1.38	4	36.17	32.87
Oct 13, 1981	220	10.98	50	77	6.33	23	190	8.27	38	54	1.38	6	26.96	27.37
June 09, 1981	258	12.87	44	87	7.16	24	188	8.18	28	51	1.30	4	29.51	29.23
June 12, 1980	300	14.96	42	108	8.89	25	240	10.43	29	44	1.13	3	35.41	36.87
Nov 21, 1979	310	15.46	35	95	7.82	18	435	18.91	43	60	1.53	4	43.73	42.89
Sept 12, 1979	390	19.45	39	100	8.23	17	470	20.43	41	60	1.53	3	49.65	48.24
June 06, 1979	230	11.47	36	95	7.82	24	260	11.30	35	60	1.53	5	32.13	32.47
Sept 21, 1978	186	9.28	42	69	5.68	25	169	7.35	33	0	0	0	22.30	21.35
May 06, 1978	130	6.48	41	40	3.29	21	130	5.65	36	18	0.46	3	15.89	15.44
June 10, 1977	370	18.45	34	100	8.23	15	630	27.39	51	0	0	0	54.08	56.27

ANIONS

	Cl			SO_4			HCO_3			CO_3				
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	ANION TOTAL	CATION TOTAL
Sept 18, 1985	8.5	0.24	10	57	1.19	50	47	0.94	40	0	0	0	2.37	2.41
June 13, 1984	13	0.37	17	44	0.92	44	41	0.82	39	0	0	0	2.10	2.33
Nov 16, 1983	3.0	0.08	5	24	0.50	30	54	1.08	65	0	0	0	1.66	1.66
June 13, 1983	5.0	0.14	8	30	0.63	36	48	0.96	56	0	0	0	1.73	1.70
Nov 16, 1982	4.8	0.14	9	30	0.63	41	39	0.78	50	0	0	0	1.55	1.63
June 16, 1982	160	4.51	14	970	20.18	61	375	7.50	23	34	0.68	2	32.87	36.17
Oct 13, 1981	160	4.51	16	800	16.66	61	378	6.20	23	0	0	0	27.37	26.96
June 09, 1981	166	4.68	16	850	17.00	61	418	6.85	23	0	0	0	29.23	29.51
June 12, 1980	310	8.73	24	1060	22.06	60	371	6.08	16	0	0	0	36.87	35.41
Nov 21, 1979	565	15.92	37	1060	22.06	51	300	4.92	11	0	0	0	42.89	43.73
Sept 12, 1979	840	23.66	49	960	19.98	41	281	4.60	10	0	0	0	48.24	49.65
June 06, 1979	300	8.45	26	770	16.02	49	488	8.00	25	0	0	0	32.47	32.13
Sept 21, 1978	213	6.00	28	308	6.41	30	545	8.94	42	0	0	0	21.35	22.30
May 06, 1978	150	4.23	27	270	5.62	36	342	5.60	36	0	0	0	15.44	15.89
June 10, 1977	1300	36.62	65	170	14.78	26	298	4.88	9	0	0	0	56.27	54.08

TABLE III

MAJOR ION CHEMISTRY
BOOTH QUARRY-GW-1-82

CATIONS

	Ca			Mg			Na			K			CATION TOTAL	ANION TOTAL
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM		
Sept 18, 1985	60	2.98	28	20	1.61	15	135	5.83	54	17	0.43	3	10.85	11.24
June 13, 1984	60	3.00	25	18	1.48	13	160	6.96	59	15	0.38	3	11.82	12.19
Nov 16, 1983	74	3.70	29	21	1.73	13	160	6.96	54	18	0.46	4	12.85	12.02
June 13, 1983	57	2.85	24	18	1.48	12	165	7.17	61	16	0.41	3	11.91	12.27
Nov 16, 1982	53	2.65	25	17	1.40	13	136	5.91	57	21	0.54	5	10.50	11.27
June 16, 1982	65	3.24	34	16	1.32	14	103	4.48	46	24	0.61	6	9.65	7.60
June 06, 1979	166	7.98	47	65	5.35	31	84	3.65	21	5	0.13	1	17.12	19.20
June 10, 1977	110	5.49	53	54	4.44	43	11	0.48	5	0	0	0	10.41	14.64

ANIONS

	Cl			SO_4			HCO_3			CO_3			ANION TOTAL	CATION TOTAL
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM		
Sept 18, 1985	99	2.78	25	115	2.40	21	303	6.06	54	0	0	0	11.24	10.85
June 13, 1984	92	2.59	21	163	3.40	28	310	6.20	51	0	0	0	12.19	11.82
Nov 16, 1983	95	2.68	22	150	3.13	26	285	5.70	47	26	0.52	4	12.02	12.85
June 13, 1983	93	2.62	21	180	3.75	31	295	5.90	48	0	0	0	12.27	11.91
Nov 16, 1982	63	1.77	16	170	3.54	31	274	5.48	49	24	0.48	4	11.27	10.50
June 16, 1982	42	1.18	16	102	2.12	28	191	3.82	50	24	0.48	6	7.60	9.65
June 06, 1979	110	3.10	16	370	7.70	40	512	8.40	44	0	0	0	19.20	17.12
June 10, 1977	100	2.82	18	206	4.29	29	460	7.54	51	0	0	0	14.64	10.41

Note: EPM denotes equivalents per million.

TABLE IV

MAJOR ION CHEMISTRY
BOOTH QUARRY - GM-2-77

CATIONS

	Ca			Mg			Na			K				
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	CATION TOTAL	ANION TOTAL
June 13, 1984	100	5	50	42	3.46	34	32	1.39	14	6.00	0.15	2	10.00	9.69
Nov 16, 1983	136	6.80	56	45	3.70	30	35	1.52	12	7.50	0.19	2	12.22	10.17
June 13, 1983	107	5.35	53	40	3.29	32	33	1.43	14	5.9	0.15	1	10.22	11.07
Nov 16, 1982	129	6.45	63	30	2.47	24	28	1.22	12	4.6	0.12	1	10.26	10.16
June 16, 1982	115	5.74	51	46	3.78	34	34	1.48	13	6.3	0.16	1	11.16	8.05
Oct 13, 1981	97	4.84	47	43	3.54	34	39	1.70	17	7.8	0.20	2	10.28	11.36
June 09, 1981	100	4.99	48	47	3.87	37	32	1.39	13	6.2	0.16	2	10.41	11.13
June 12, 1980	92	4.59	45	44	3.62	36	40	1.74	17	6	0.15	2	10.10	10.97
Nov 21, 1979	98	4.89	46	49	4.03	38	37	1.61	15	8	0.20	2	10.73	10.81
Sept 12, 1979	130	6.48	53	49	4.03	33	34	1.48	12	9	0.23	2	12.23	11.08
June 06, 1979	100	4.99	45	55	4.53	41	34	1.48	13	7	0.18	2	11.17	12.28
Sept 21, 1978	94	4.79	48	45	3.70	37	35	1.52	15	0	0	0	10.01	11.61
May 08, 1978	85	4.24	47	40	3.29	37	30	1.30	15	5	0.13	1	8.96	12.87
Aug 22, 1977	128	6.23	56	27	2.22	20	54	2.35	21	10	0.26	2	11.06	12.28

ANIONS

	Cl			SO_4			HCO_3			CO_3				
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	ANION TOTAL	CATION TOTAL
June 13, 1984	18	0.51	5	150	3.13	32	303	6.06	63	0	0	0	9.69	10.00
Nov 16, 1983	20	0.56	6	150	3.13	31	299	5.98	59	25	0.50	5	10.17	12.22
June 13, 1983	31	0.87	8	190	3.96	36	312	6.24	56	0	0	0	11.07	10.22
Nov 16, 1982	24	0.67	7	113	2.35	23	357	7.14	70	0	0	0	10.16	10.26
June 16, 1982	23	0.65	8	104	2.16	27	247	4.94	61	15	0.30	4	8.05	11.16
Oct 13, 1981	28	0.79	7	190	3.96	35	403	6.61	58	0	0	0	11.36	10.28
June 09, 1981	28	0.79	7	192	4.00	36	387	6.34	57	0	0	0	11.13	10.41
June 12, 1980	27	0.76	7	192	4.00	36	379	6.22	57	0	0	0	10.97	10.10
Nov 21, 1979	28	0.79	7	180	3.75	35	383	6.28	58	0	0	0	10.81	10.73
Sept 12, 1979	26	0.73	7	180	3.75	34	403	6.60	60	0	0	0	11.08	12.23
June 06, 1979	26	0.73	6	190	3.95	32	464	7.60	62	0	0	0	12.28	11.17
Sept 21, 1978	26	0.73	6	145	3.02	26	479	7.86	68	0	0	0	11.61	10.01
May 08, 1978	25	0.70	5	210	4.37	34	476	7.80	61	0	0	0	12.87	8.96
Aug 22, 1977	40	1.13	9	217	4.52	37	405	8.64	54	0	0	0	12.28	11.06

Note EPM denotes equivalents per million

TABLE V

MAJOR ION CHEMISTRY
BOOTH QUARRY - GM-6-82

CATIONS

	Ca			Mg			Na			K				
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	CATION TOTAL	ANION TOTAL
Sept 18, 1985	108	5.40	39	39	3.17	23	106	4.61	33	26	0.66	5	13.84	14.84
June 13, 1984	128	6.40	43	44	3.62	24	101	4.39	29	24	0.62	4	15.03	15.26
Nov 16, 1983	155	7.75	45	48	3.95	23	106	4.61	27	29	0.74	4	17.05	16.03
June 13, 1983	124	6.20	40	45	3.70	23	117	5.09	32	29	0.74	5	15.73	16.77
Nov 16, 1982	120	6.00	37	45	3.70	23	123	5.35	34	35	0.90	6	15.95	16.09
June 16, 1982	127	6.34	39	45	3.70	23	119	5.18	32	46	1.18	7	16.40	14.45

ANIONS

	Cl			SO_4			HCO_3			CO_3				
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	ANION TOTAL	CATION TOTAL
Sept 18, 1985	63	1.78	12	292	6.00	41	353	7.06	47	0	0	0	14.84	13.84
June 13, 1984	58	1.63	11	316	6.58	43	352	7.04	46	0	0	0	15.26	15.03
Nov 16, 1983	60	1.69	11	330	6.88	43	348	6.96	43	25	0.50	3	16.03	17.05
June 13, 1983	66	1.86	11	370	7.71	46	359	7.2	43	0	0	0	16.77	15.73
Nov 16, 1982	65.5	1.85	11	333	6.94	43	333	6.7	42	30	0.60	4	16.09	15.95
June 16, 1982	67	1.89	13	350	7.28	50	240	4.8	33	24	0.48	3	14.45	16.40

Note: EPM denotes equivalents per million

TABLE VI

MAJOR ION CHEMISTRY
BOOTH QUARRY - GW-8-77

CATIONS

	Ca			Mg			Na			K			CATION TOTAL	ANION TOTAL
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM		
June 13, 1984	117	5.85	74	15	1.23	16	16	0.70	9	4.3	0.11	1	7.89	7.94
Nov 16, 1983	138	6.90	72	15	1.23	13	31	1.35	14	1.5	0.04	0	9.52	7.95
June 13, 1983	100	5.00	68	13	1.07	15	29	1.26	17	1.5	0.04	0	7.37	7.91
Nov 16, 1982	122	6.10	70	16	1.32	15	30	1.30	15	1.7	0.04	0	8.76	8.66
June 16, 1982	133	6.64	71	14	1.15	12	35	1.52	16	1.4	0.04	0	9.35	7.50
Oct 13, 1981	127	6.34	68	17	1.40	15	34	1.48	16	2.3	0.06	0	9.28	10.29
June 09, 1981	124	6.19	69	15	1.23	14	34	1.48	17	1.6	0.04	0	8.94	9.10
June 12, 1980	112	5.59	65	16	1.28	15	40	1.74	20	2	0.05	1	8.66	9.45
Nov 21, 1979	128	6.38	67	16	1.32	14	41	1.78	19	2	0.06	1	9.54	9.71
Sept 12, 1979	150	7.48	70	15	1.23	12	43	1.87	18	4	0.10	1	10.68	9.30
June 16, 1979	140	6.98	67	18	1.48	14	43	1.87	18	2	0.05	0	10.38	10.80
Sept 21, 1978	118	5.89	68	15	1.23	14	36	1.57	18	0	0	0	8.69	20.05
May 08, 1978	280	13.97	65	15	1.23	6	145	6.30	29	1	0.03	0	21.53	14.15
Aug 22, 1977	180	8.98	56	53	4.36	27	62	2.70	17	5	0.13	1	16.16	13.46

ANIONS

	Cl			SO_4			HCO_3			CO_3			ANION TOTAL	CATION TOTAL
Date	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM	mg/L	EPM	ΣEPM		
June 13, 1984	47	1.32	17	90	1.88	23	237	4.74	60	0	0	0	7.94	7.89
Nov 16, 1983	23	0.65	8	100	2.08	26	239	4.78	60	22	0.44	6	7.95	9.52
June 13, 1983	29	0.82	10	105	2.19	28	245	4.90	62	0	0	0	7.91	7.37
Nov 16, 1982	24	0.68	8	94	1.96	25	301	6.02	69	0	0	0	8.66	8.76
June 16, 1982	32	0.90	12	80	1.66	22	230	4.60	61	17	0.34	5	7.50	9.35
Oct 13, 1981	28	0.79	8	120	2.50	27	427	7.00	68	0	0	0	10.29	9.28
June 09, 1981	37	1.04	11	120	2.50	27	339	5.56	61	0	0	0	9.10	8.94
June 12, 1980	34	0.56	10	140	2.91	31	340	5.58	59	0	0	0	9.45	8.66
Nov 21, 1979	35	0.99	10	136	2.83	29	360	5.90	61	0	0	0	9.71	9.54
Sept 12, 1979	35	0.99	11	140	2.91	31	329	5.40	58	0	0	0	9.30	10.68
June 16, 1979	46	1.30	12	130	2.71	25	415	6.80	63	0	0	0	10.80	10.38
Sept 21, 1978	51	1.44	7	538	11.20	56	453	7.42	37	0	0	0	20.05	8.69
May 08, 1978	85	2.39	17	200	4.16	29	464	7.60	54	0	0	0	14.15	21.53
Aug 22, 1977	105	2.96	22	197	4.10	30	390	6.40	48	0	0	0	13.46	16.16

Note: EPM denotes equivalents per million

TABLE VII

SURVEY OF WATER TABLE AT BOOTH QUARRY ASH DISPOSAL SITE
JUNE, 1982 TO AUGUST, 1985

Observation Well Location	Elevation* of Ground Level (m)	Elevation* of Water Table (m)					
		82 06 21	82 11 05	83 06 08	83 11 09	84 06 08	85 08 29
OW-1-82	103.44	100.81	101.05	101.19	100.91	101.15	101.11
OW-2-77	102.07	101.36	101.58	101.32	100.85	101.14	NA
OW-6-82	101.51	99.08	99.15	99.43	99.31	99.51	99.60
OW-7-82	101.41	97.00	97.03	97.36	N.D.**	N.D.**	98.72
OW-8-77	102.25	100.46	100.55	100.40	100.14	100.27	NA†
Central Sump	101.46	96.47	96.87	97.56	97.79	98.71	99.18

* All elevations refer to geodetic datum.
** N.D. denotes not determined - observation well practically dry.
† NA denotes not accessible due to local construction.

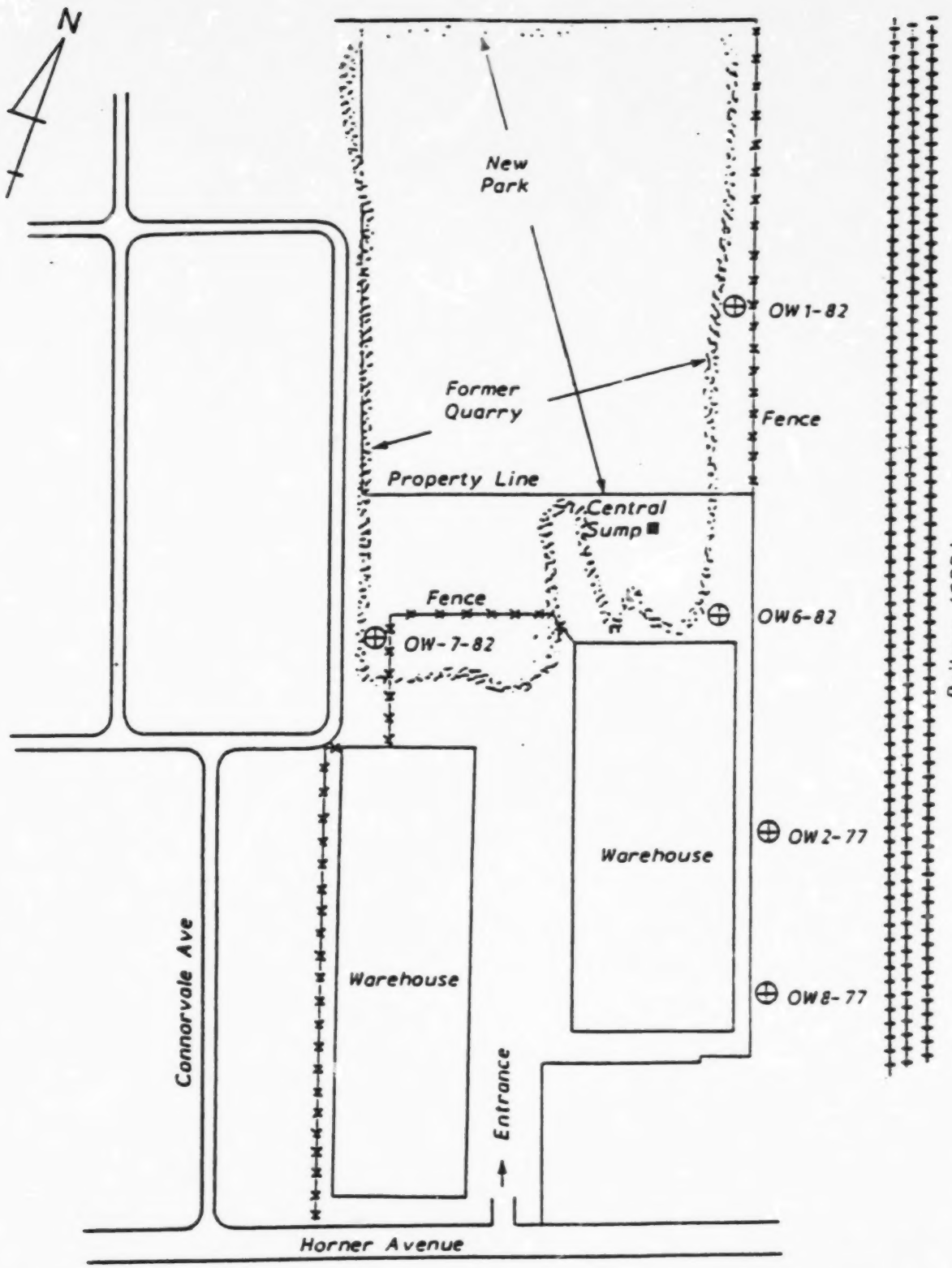

FIGURE 1

BOOTH QUARRY ASH DISPOSAL SITE
(Not to Scale)

158887-RD

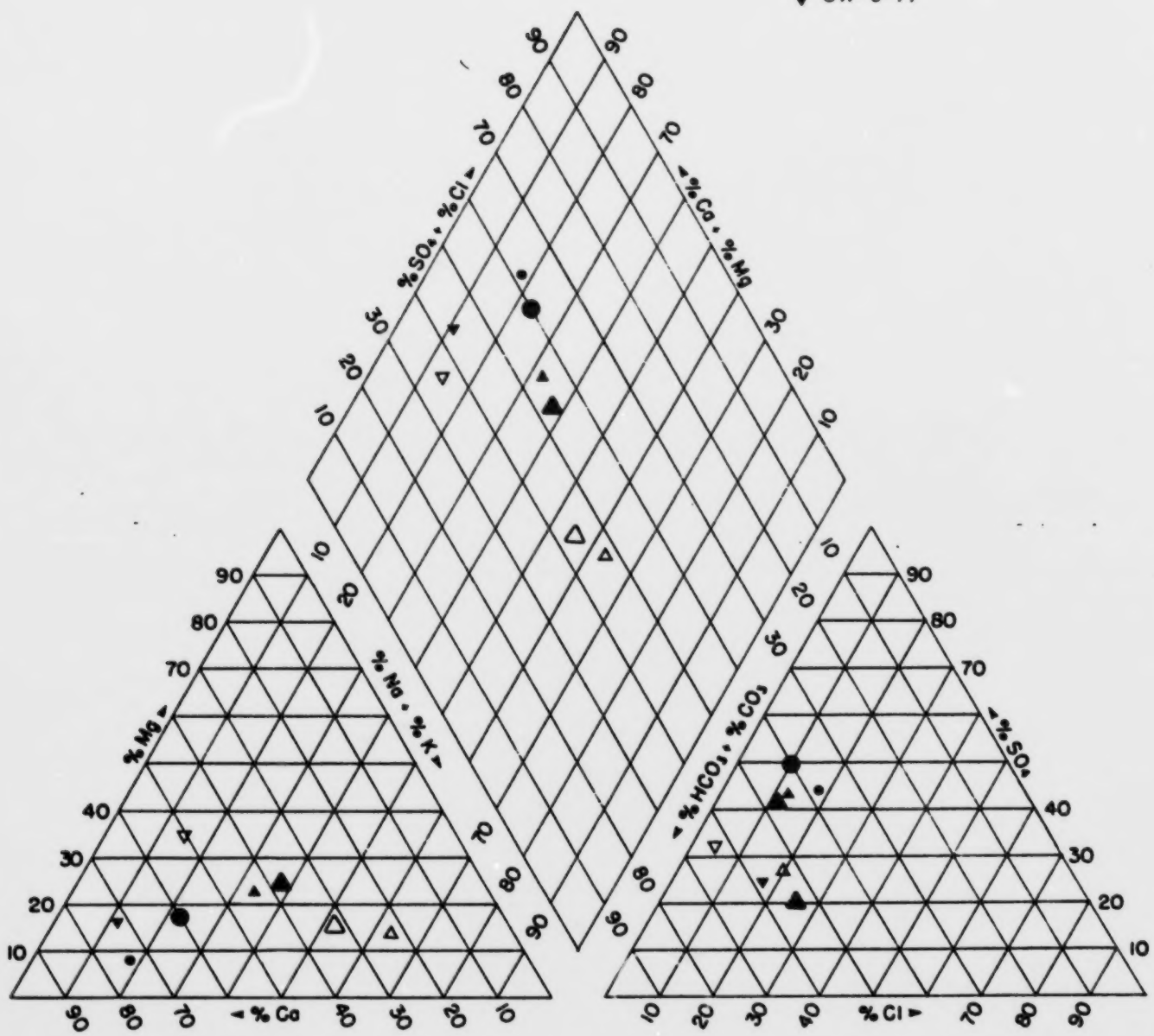

FIGURE 2

BOOTH QUARRY PIPER DIAGRAM
MAJOR ION CHEMISTRY
ALL LOCATIONS SAMPLED SEPTEMBER, 1985
AND (FOR COMPARISON) JUNE, 1984

167333 RD
85-346

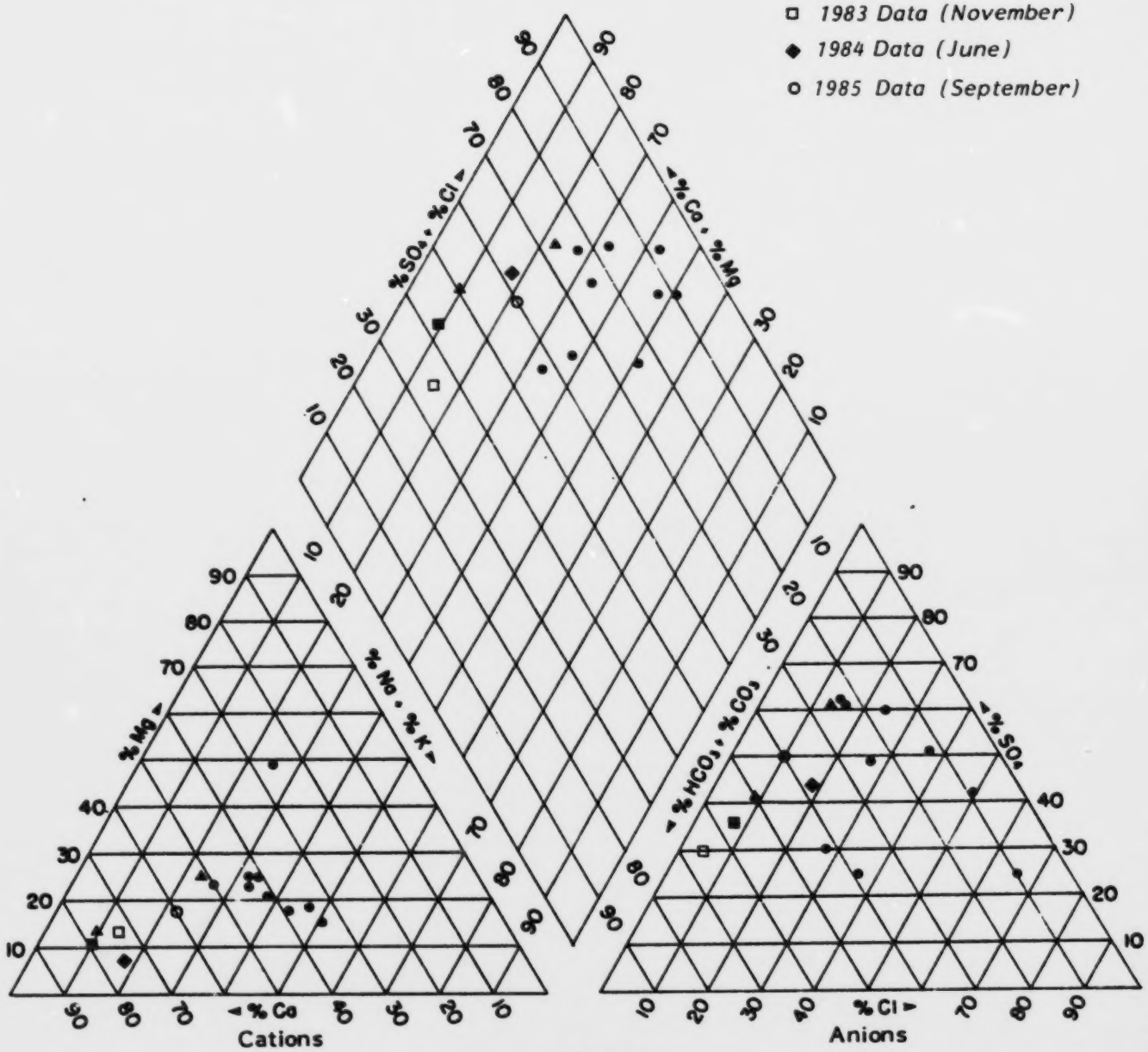

FIGURE 3

BOOTH QUARRY PIPER DIAGRAM
MAJOR ION CHEMISTRY
LOCATION: CENTRAL SUMP

164626 RD

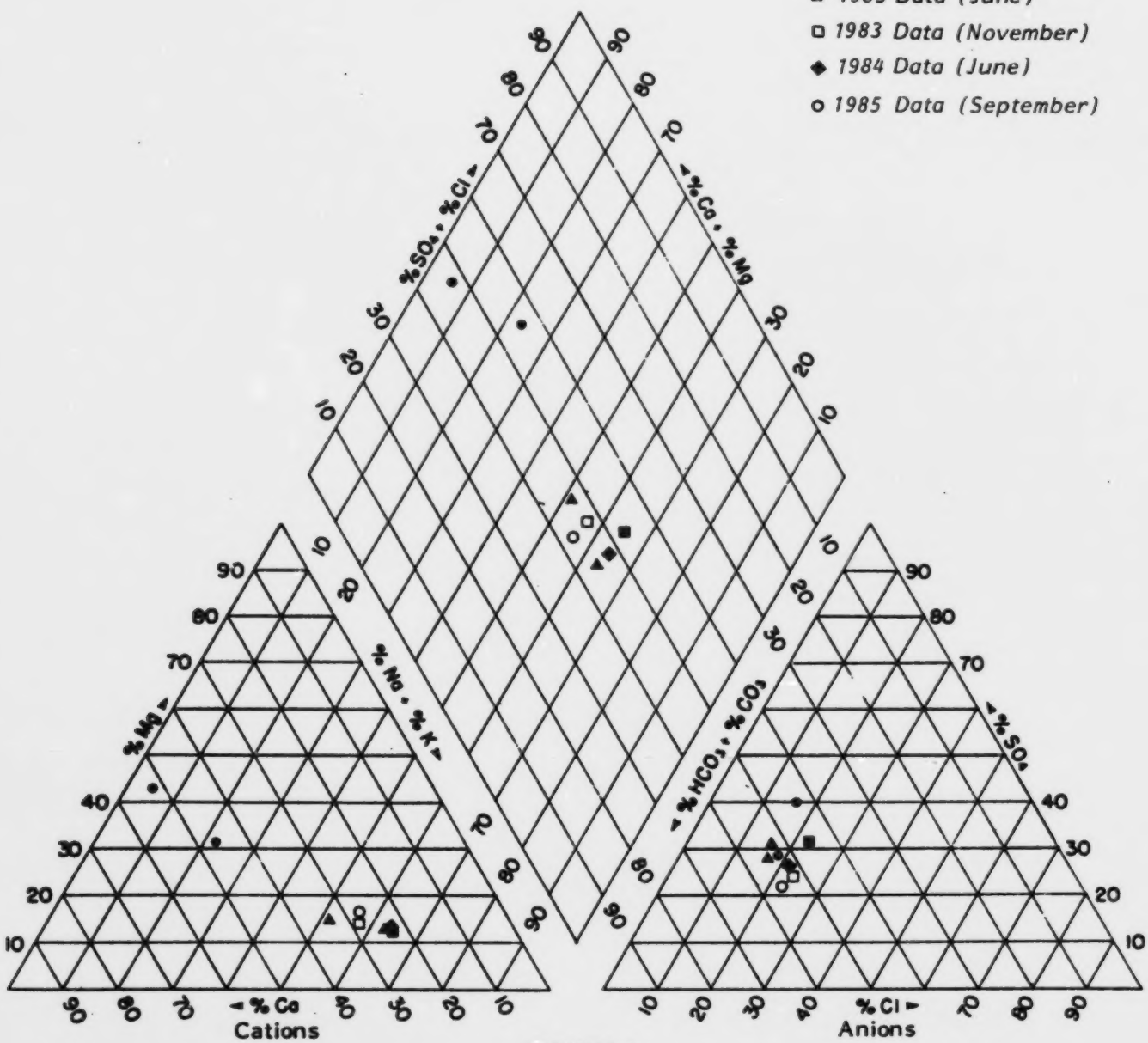

FIGURE 4

BOOTH QUARRY PIPER DIAGRAM
MAJOR ION CHEMISTRY
LOCATION: OW-1-82

164627 RD

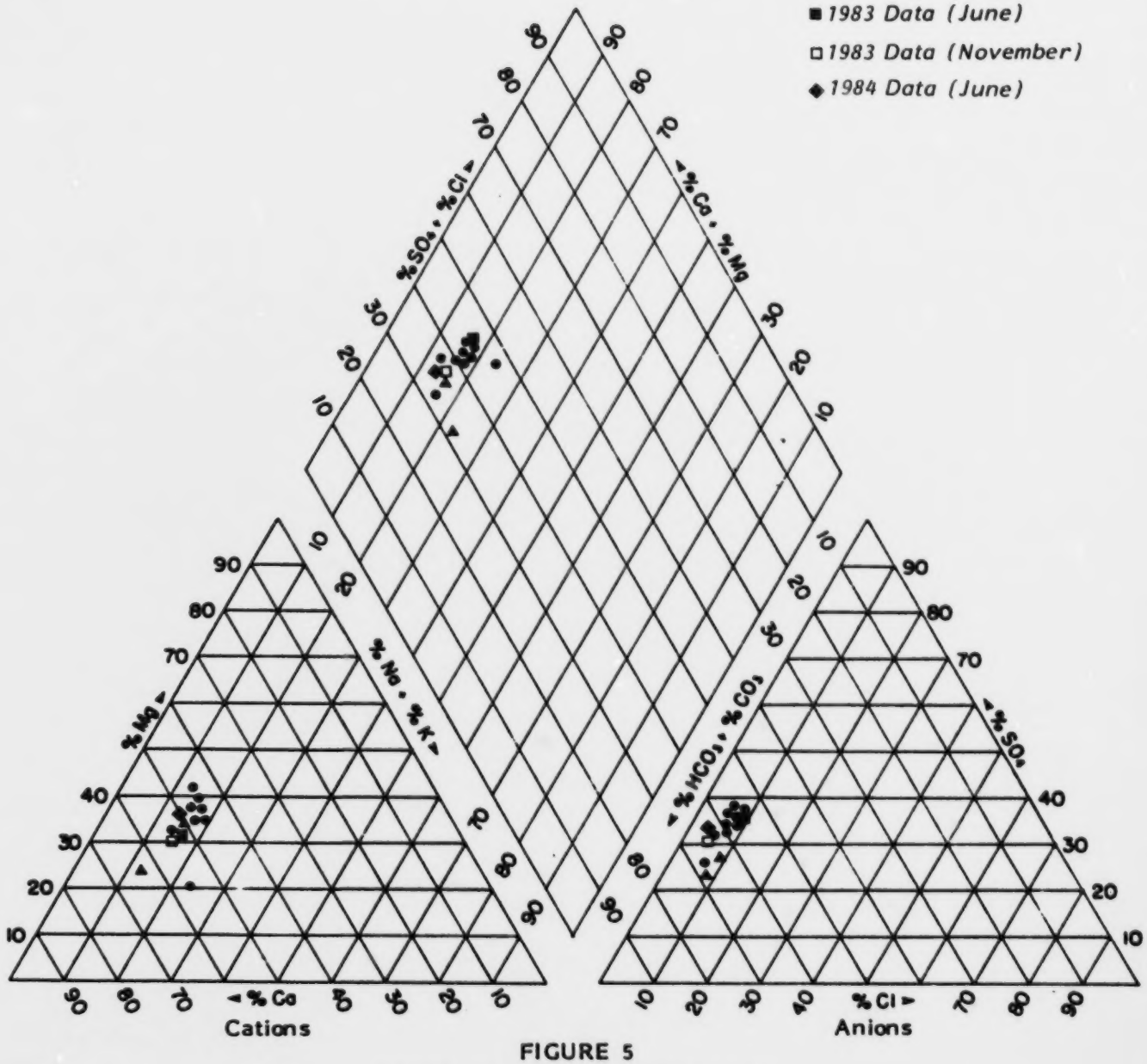

FIGURE 5

BOOTH QUARRY PIPER DIAGRAM
MAJOR ION CHEMISTRY
LOCATION: OW-2-77

164628 RD

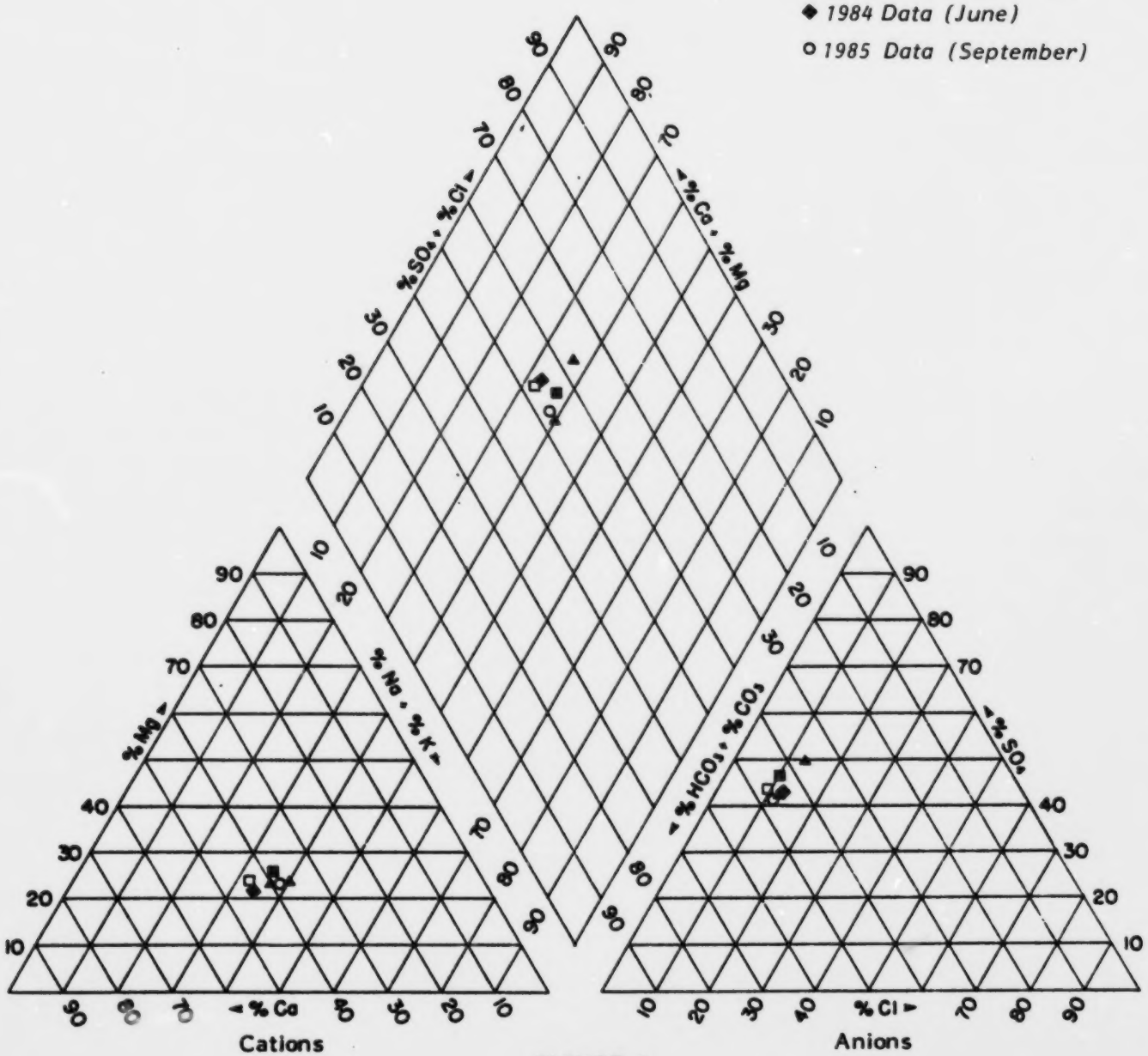

FIGURE 6

BOOTH QUARRY PIPER DIAGRAM
MAJOR ION CHEMISTRY
LOCATION: OW-6-82

164629 RD

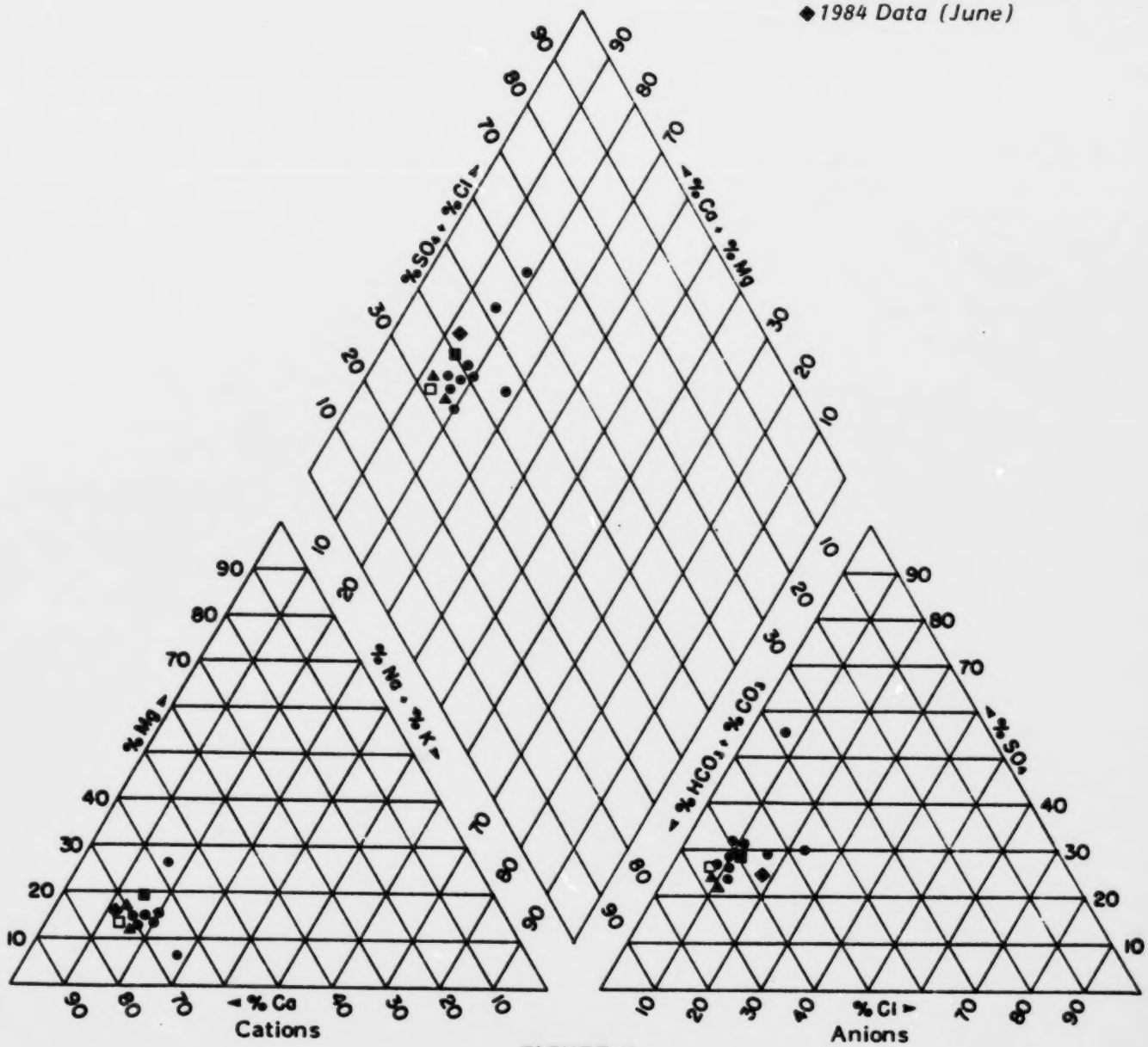

FIGURE 7

BOOTH QUARRY PIPER DIAGRAM
MAJOR ION CHEMISTRY
LOCATION: OW-8-77

164630 RD

DISTRIBUTION

Mr. D. Erwin	Supply Division, H6A24
Mr. J.H.P. Buckingham (3)	Supply Division, KN100
Dr. T.W. Klym	Civil Research
Dr. B.R. Nott	Chemical Research
Mr. A.Z. Mlynarczyk	Chemical Research
Dr. A. Golomb (2)	Chemical Research
Mrs. K. Wittmann (Title page only)	Chemical Research

Public Reference Centre
Editorial Section
Office Copies (3)
Extra Copies (3)